

SKF



Main Bearing Preventive Maintenance & Condition Monitoring Techniques

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Typical maintenance techniques today

Maintenance strategies to improve reliability

Preventive

- Manual inspection of bearing
- Re lubrication of bearing

Predictive

- Continuous condition monitoring

Typical maintenance techniques today

- Manual re lubrication - 6 & 12 months scheduled maintenance
- Automated lubrication
- Some utilizing condition based monitoring

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Main Bearing Inspection and Maintenance

Example 3 point bearing system

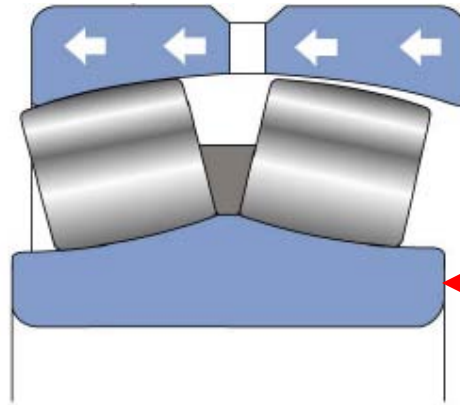
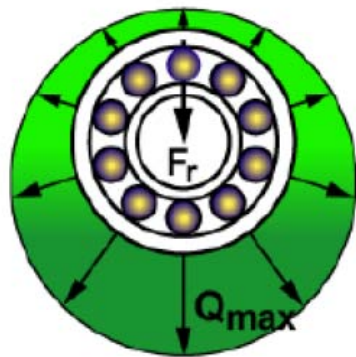
Increasing number of main bearing failures in the market

Root cause still under investigation

Lubrication is one possible cause

Heavy loads on Down wind side of bearing

Light load on upwind side of bearing



Upwind Side Load Zone



Grease separation - a growing concern

Grease separation

- Oil separating from thickener
- Thickener hardening
- No “mixing”

Hardened grease preventing proper lubrication

- Blocking the bearing grease path(W33 groove)



Corrective measures

- Manual inspection of bearings every two years (once if auto lubrication system is used)
- Increase grease quantity to 100% fill
- Increase schedule manual relubrication
- Good experience with NLGI 1 grease due to easier pumpability, shear characteristics and ability to operate all weather conditions



Manual Inspection of Bearing

On Models that the front cover can be removed

Grease

- Condition and amount
- Grease path
- Grease Samples
- Remove old grease

Bearing

- Measure internal clearance
- Inspect inner and outer of bearing for damage (spalling, fragment denting, etc)
- Inspect rollers (Smearing on face, fragment denting, etc)



Re lubrication

Manually grease bearing using the inlet port at the top of the bearing

- Grease should emerge from center of bearing
- Remove any old grease pushed from inside bearing.
- Grease can now be hand packed
- Reassemble Bearing
- Continue to add grease until new grease comes out of portal at the bottom of housing



Bearings that can not be disassembled



Contact bearing manufacture for calculation of 100% Free space fill

Open the grease outlet at the bottom of housing

Pump calculated amount of grease into housing inlet

If possible rotate Shaft several times

When new grease begins to come out of outlet.

Rotate shaft for several minutes and replace plug in outlet

Auto Lubrication Systems



Benefits of Auto Lubrications

- Small amount of grease added often (1 minute every 6 hours)
- Reduced heat
- Reservoir will hold enough grease for a year or more
- Using the IFM module grease will be added only while turbine is operating
- Reduced cost



Less waste, buy in bulk, reduced man hours

Summary - Main Bearing Inspection and Maintenance

- Root cause failure still under investigation, Lubrication is one possible cause
- Recommend manual inspection every 2 years if continuing with manual re lubrication
- Recommend manual inspection before installing auto lubrication system
 - Small amount of grease added daily reduces heating, oil separation (hardening), Improves oil film.
 - Proper lubricating procedures will increase bearing life

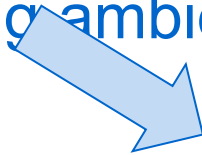
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Main Bearing Condition Monitoring

Condition monitoring at the main bearing

Challenges,

- Slow rotating bearing
- Variable speed and load conditions
- Relatively low shaft rotational speed – typically < 20 rpm
- Transmitted vibration (tower resonance, gearbox, etc.)
- Changing ambient temperature



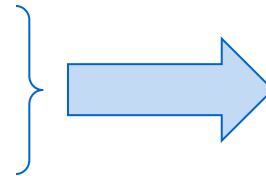
All points influence the vibration values

Methods for predictive maintenance

Different methods/techniques used to measure the condition,

➤ Temperature

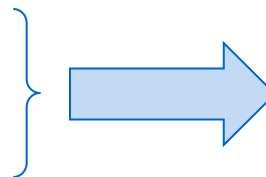
➤ Lubrication (grease) analysis



Main bearing

➤ Overall Vibration values

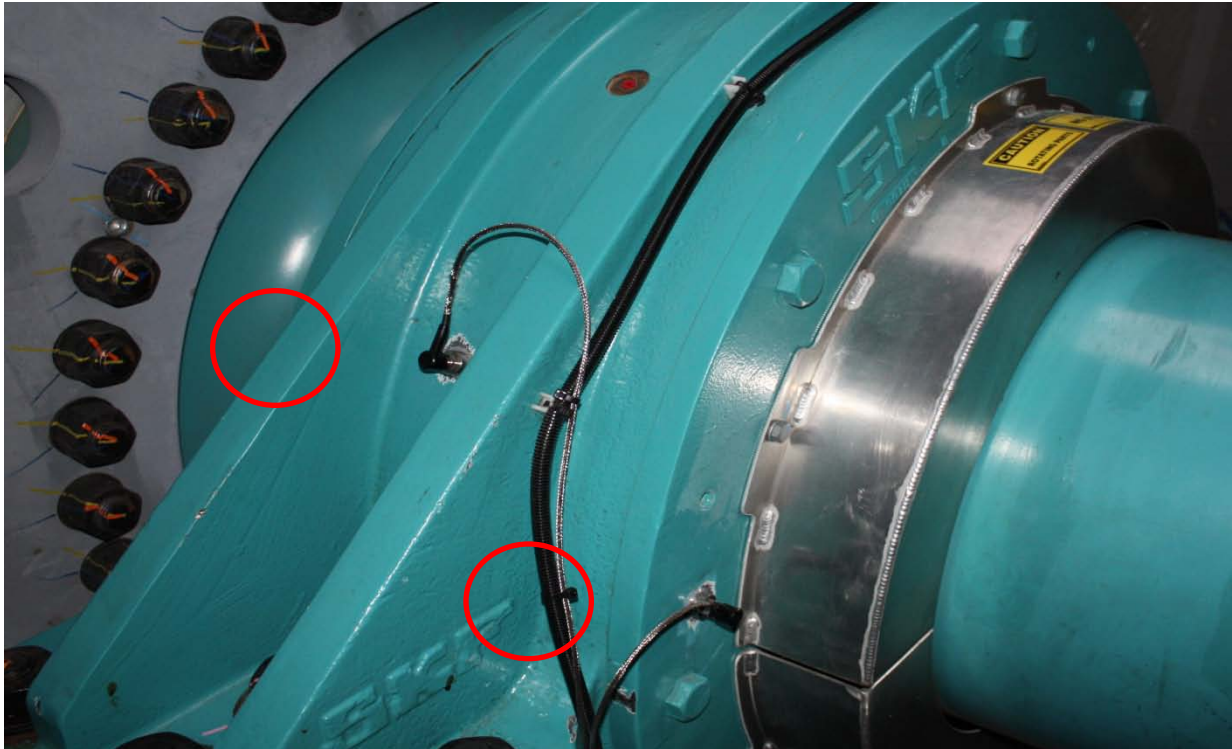
➤ Spectral analysis



Main bearing and rotor

On-site preparation/sensor location

Sensor locations at the main bearing



- 2 Sensors recommended > axial and radial directions
- Low frequency sensors required to detect running speed frequency
- Sensors should have a high sensitivity to detect bearing failures (low energy)

Requirements of the condition monitoring system

- Minimum 16 bit dynamic resolution, better 24 bit
- New CMS should have order tracking
- Spectra and trend data should be recorded at similar conditions

Active range					
	Type:	Speed	Condition:	1700	1850 [cpm]
					Max allowed delta: 30 [cpm]
	Type:	Process	Condition:	1300	1500 [kW]
					Max allowed delta: 50 [kW]


Benefit of “active ranges”:

- Saved spectra without “smearing” if used with allowed delta
- Better stable trend values – no up and down
- No grab spectra

Measurement setup – slow speed

- Due to the slow speed, a long measurement time is needed
- Min. 12 main shaft revolutions should be taken inside the meas. time
- Fmax should include the 4 harmonic defect frequency

FFT settings



No. of lines:	1600	No. samples:	4096
No. revolutions:	16	Max order:	100 X
Window:	Hanning	Resolution:	0,0625 X/Line
Low freq.:	0,3 [X]		
Average:	Frequency	Number:	1
Order analysis shaft:	MS		

Order tracking setup

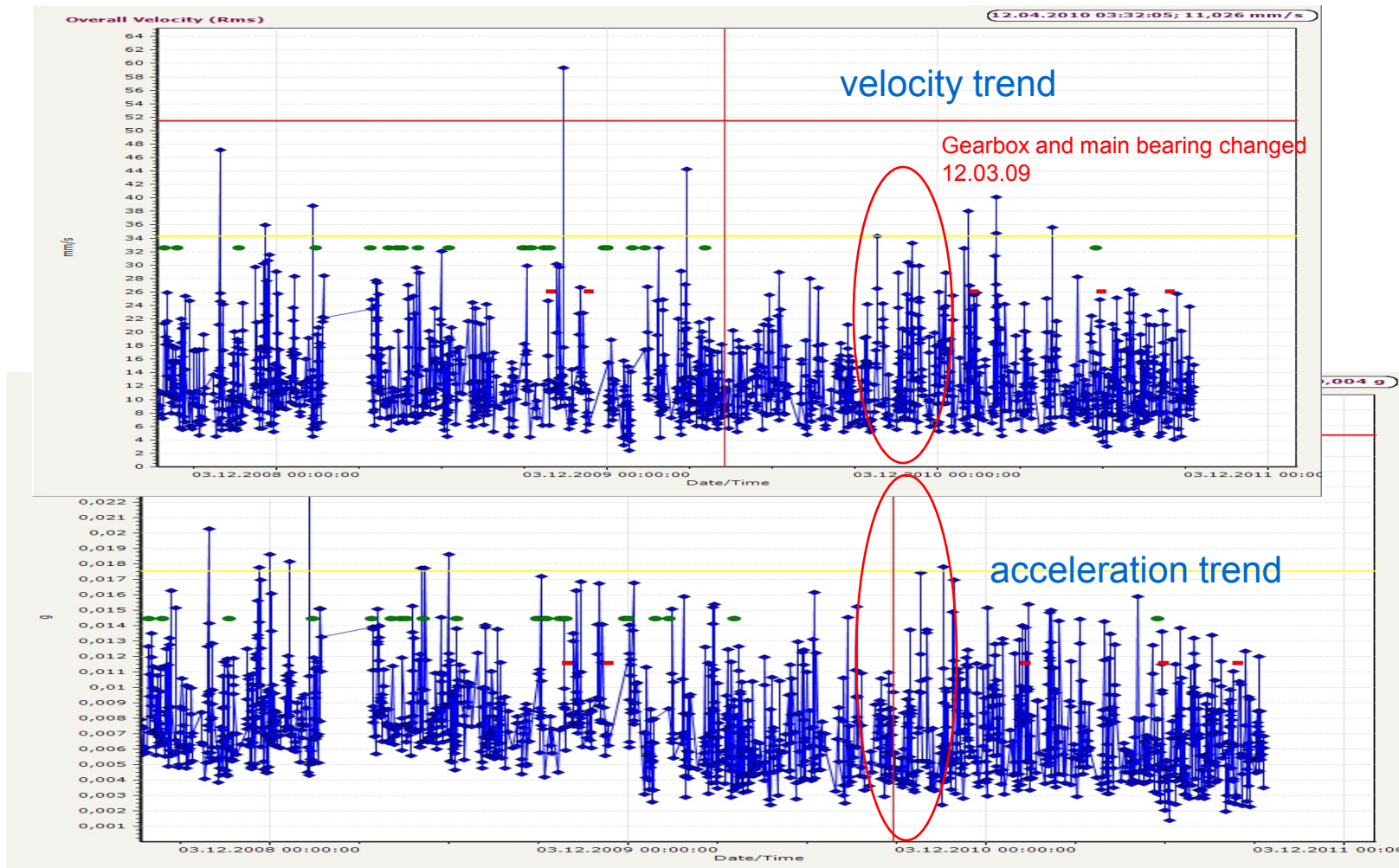
Example of a main bearing defect

Turbine data:

- 1.5 MW turbine
- Life time 9 years
- Onshore
- Three point bearing design (1 main bearing / gearbox)
- Spherical Roller Bearing
- Similar to several main bearing defects

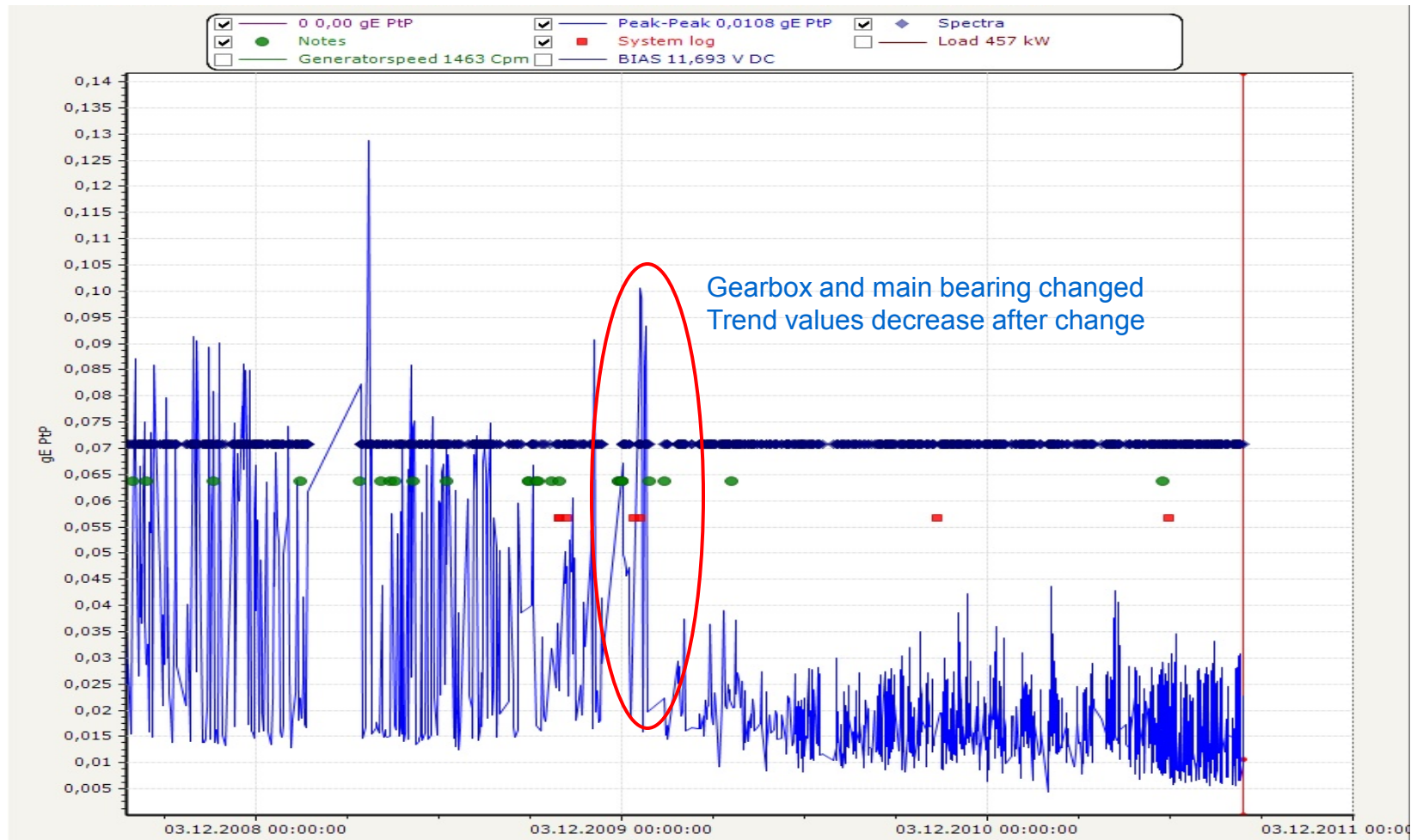


Comparison of different trend data



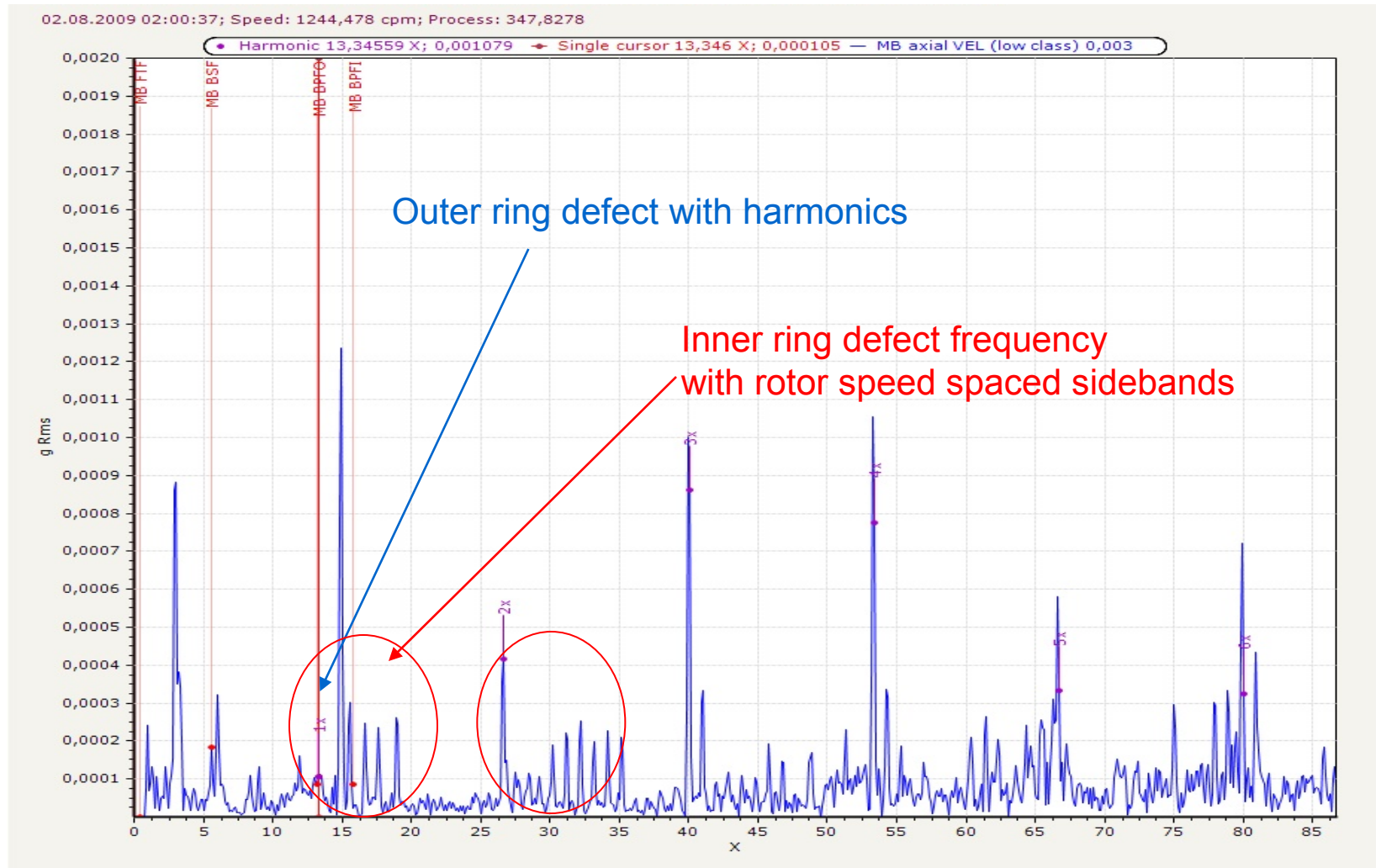
Overall trends are not reliable to track main bearing issues.
Good for rotor/blades and tower vibration

Envelope Trend (envelope filter -200Hz)



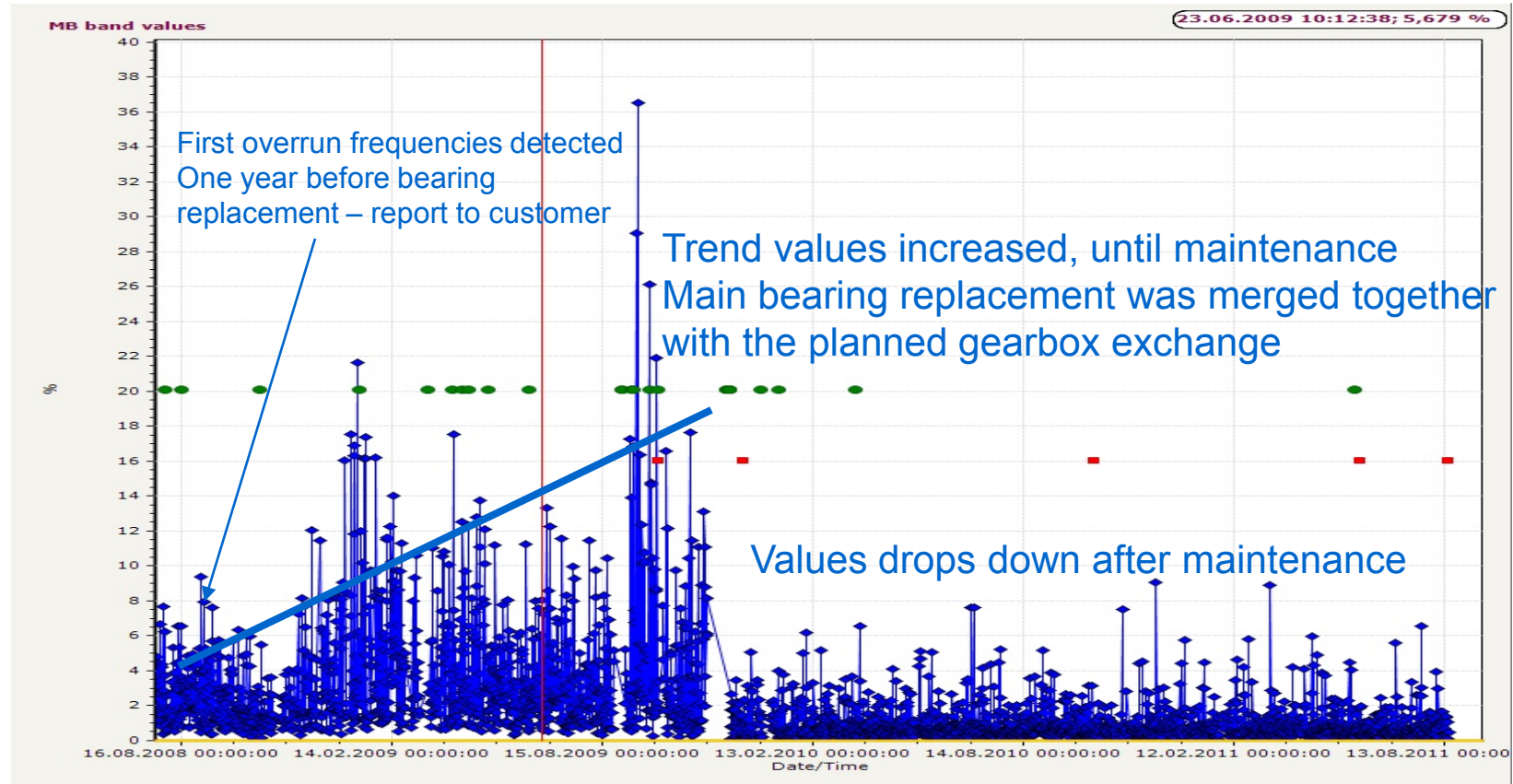
The envelope trend value is more appropriate to detect bearing failures

Main bearing defect – acceleration spectra



Diagnostic techniques in SKF software

Benefit: Gearbox replace could be merged together with the main bearing replacement



Diagnosis trend:

Software generated band values around the bearing defect values

It is possible to track the defect development

Analysis is performed automatically by the software – reduces the needed analysis time

Pictures of the damaged bearing



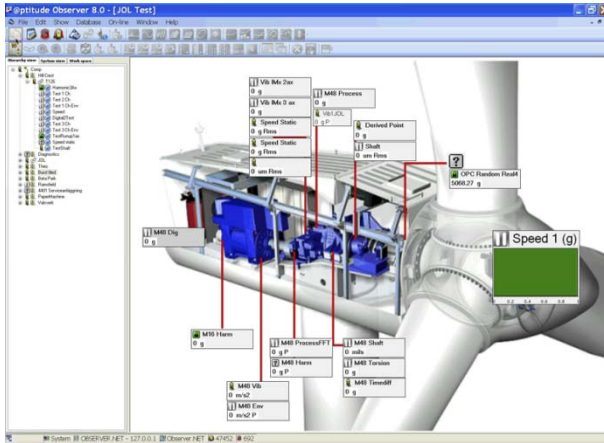
Condition Monitoring Summary

- Main Bearing defect analysis/identification is achievable
- Accurate & reliable main bearing defect analysis is not easy
- SKF have proven reliable techniques, along with specific application experience to analyze and detect main bearing defects
- Most main bearing defects visible in axial and radial directions
- Best to measure in acceleration spectrum
- Most main bearing defects exhibit low fundamental bearing defect frequency amplitudes, compared to the harmonics
- At low wind classes (low load), the defect is often more visible/easier to diagnose (less transmitted frequencies)

Next Steps.....

Connecting Technologies.....

Connecting Condition Monitoring & Auto Lubrication



Observer software

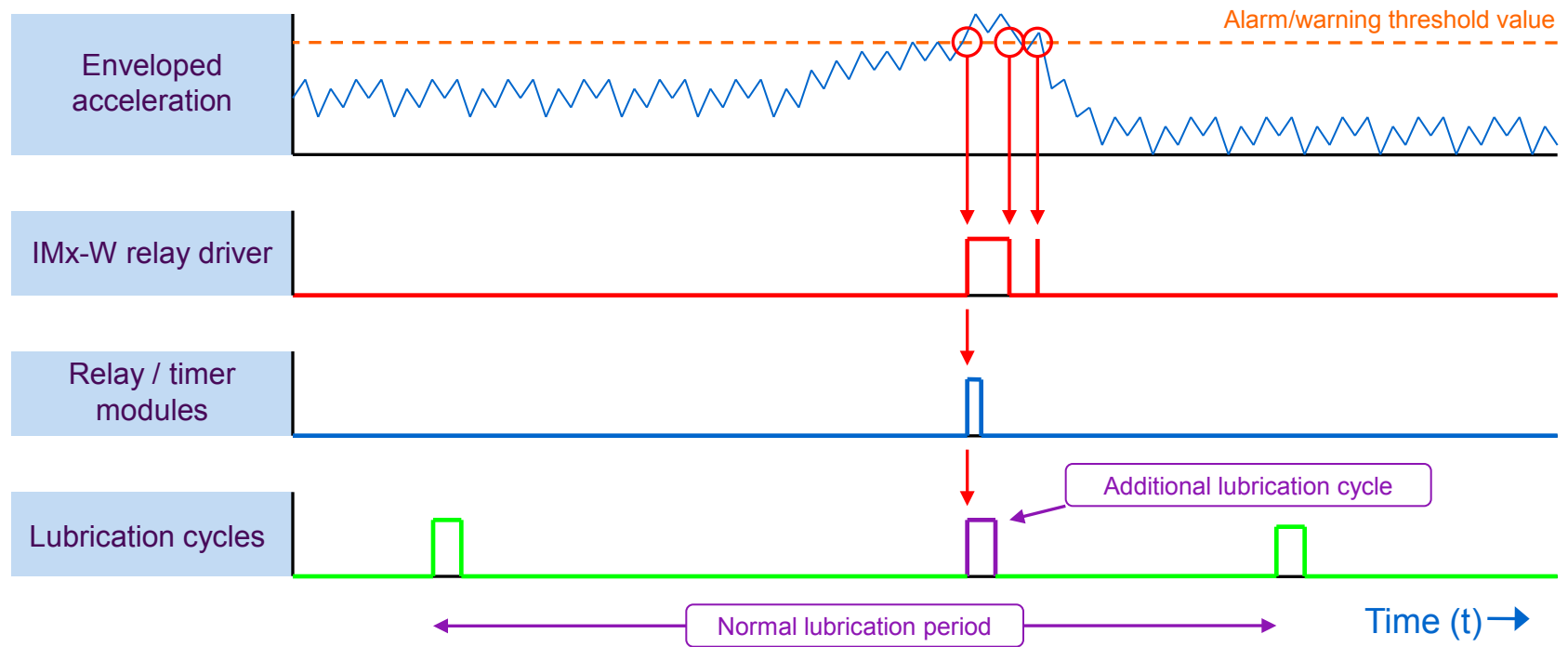


WindCon



WindLub

Working principle



Thank you – any questions please

